ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

IJESRT

INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY

A SURVEY ON ALOHA PROTOCOL FOR IOT BASED APPLICATIONS

Shikha Badgotya[*1] & Prof.Deepti Rai[2]

[*1]M.Tech Scholar, Department of EC, Alpine Institute of Technology,, Ujjain (India)

[2]H.O.D, Department of EC, Alpine Institute of Technology, Ujjain (India)

DOI: 10.5281/zenodo.1246995

ABSTRACT

With the emergence of IoT based applications in industries and automation, protocols for effective data transfer was the foremost need. The natural choice was a random access protocol like ALOHA which could be incorporated in the ultra narrowband ISM band framework because of its simplicity and lack of overhead. Pure ALOHA faced the limitation of greater rate of collisions among the packets of data and also there was higher level of frame delays. Slotted ALOHA overcame these limitations to some extent in which the transfer of data takes place after channel polling. Though the drawbacks of PURE ALOHA are somewhat resolved in Slotted ALOHA, still some redundant transmissions and delay of frames exist. The present proposed work puts forth an efficient mechanism for Slotted ALOHA which implements polling of channel that is non persistent in nature to reduce the probability of collisions considerably. Further it presents a channel sensing methodology also for prevention of burst errors. Interleaving serves to be useful in case of burst errors and helps in preserving useful information. The survey should pave the path for IoT based applications working on an ultra narrowband architecture.

Keywords: Internet of Things (IoT), Ultra Narrowband (UNB), Pure ALOHA, Slotted ALOHA, Throughput, Bandwidth Efficiency, Bit Error Rate (BER).

I. INTRODUCTION

Internet of Things (IoT) has emerged as one of the most potent technologies of the future. One major challenge that needs to be overcome in terms of IoT based systems is its limited bandwidth or ultra narrowband spectrum. Random access protocols are hence the most effective techniques to implement the IoT based applications. Hence ALOHA became the natural choice due to its simplicity. The history of ALOHA can be traced back to the month of June, in 1971, ALOH Anet became functional. It represented the first wireless packet data network publicly. [4] ALOHA stood for Additive Links On-line Hawaii Area originally. This was a protocol that was made particularly as part of a project of University of Hawaii. The computers on Hawaii islands got interconnected through this concept of networking. It was simple medium of communication developed to facilitate transmission of data through frames. It was originally made to carry out satellite communications. It served as the foundation for Ethernet and Wi-Fi. It initially incorporated medium access concepts with the UHF frequencies. The very first type of the ALOHA comprised of two different frequencies in a configuration of hub. The ALOHA Channels were used in a limited manner back then only for the purpose of signal and control. With rise in technology advancement and widespread use of GPRS, ALOHA channels started to be added with the GPRS mediums in the 3G enabled phones that time.

The interaction and communication was carried out mainly between distant stations via a main site that was namely Menehune. The frequency to send the message data to Menehune was the same. On reception of the signal back by Menehune, an acknowledgement (ACK) would be sent back in a different frequency. Other frequencies were also used for sending out data to remote located computers.[7] It relied on and implemented ultra high frequency for functioning. Before the assignment of various frequencies to ALOHA channel operation, satellites and cables were other tow application mechanisms of ALOHA channel. It is a class of the multiple access protocols.

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

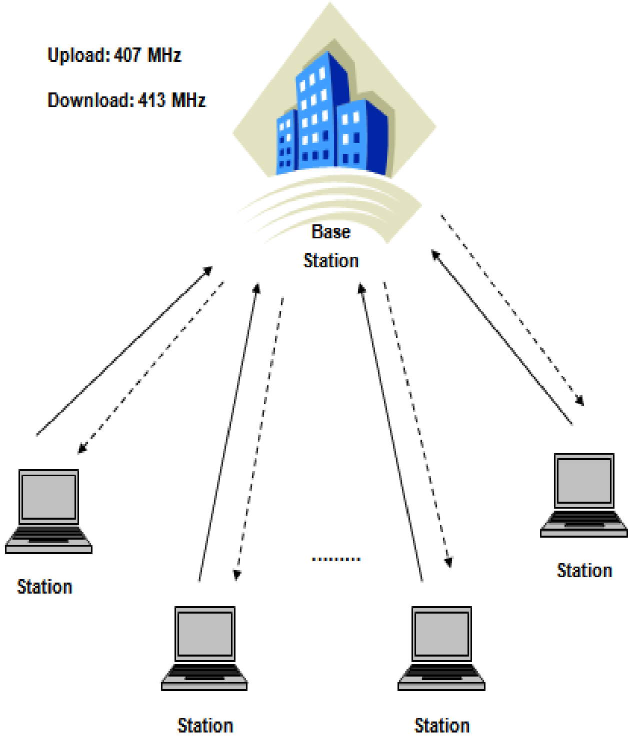

Fig.1 A Typical model for ALOHA network

The figure above depicts the typical architecture of an ALOHA based framework wherein several nodes or stations are connected to a main base station. The spectrum for uploading (up-link) has been shown as 407MHz whereas that for the downloading (down-link) has been taken as 413 MHz The various protocols followed for the data transfer are enlisted below:

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

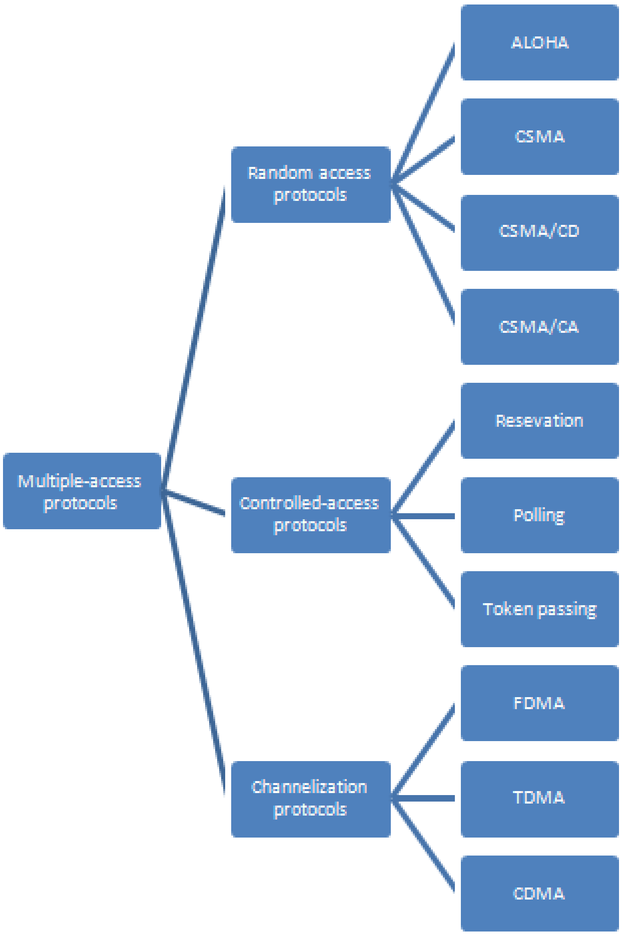

Fig.2 ALOHA as a class of Multiple access protocols

The various multiple access protocols which are used for the transmission of uplink and downlink ends are shown below. ALOHA basically belongs to the random access control category wherein the data is transmitted and received as and when required. No fixation in the time domain is done which makes ALHOHA a preferable choice for data transfer in IoT based applications where a central host may send or receive data from different receivers or stations as required. The most important challenge that needs to be fixed in the case of ALOHA is the collision avoidance between data packets of different users due to the Narrowband (NB) applications of IoT.
Various technique for the enhancement of system performance in terms of reduced collisions i.e. collision avoidance are used wherein different techniques are used. The majority of the approaches need to address the issues related to:
1) BER degradation
2) Plummeting Throughput due to extended waiting delays or channel polling and sensing.

The subsequent section throws light on different commonly used techniques used for the purpose of addressing these issues.

II. PREVIOUS WORK

M. Sarper Gokturk et al. carried out a research on Throughput Analysis of ALOHA with cooperative diversity. It works on the basis of following the mutli-antenna mechanisms and also enhances the quality of signal reception. In this study, they analyzed a cross layer random access medium ,C-ALOHA that makes possible the cooperative transfer of the data in the ALOHA system. Results further signified that C-ALOHA improves the throughput considerably.

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

Mariam Kaynia et al. started analysis on Unslotted ALOHA and CSMA in spatially distributed networks. The packets generally come in random manner. . It works according a Poisson method with data packets arriving randomly in time and space. It was distributed employing the MAC protocol. An SINR based model was taken and researched about. Receiver sensing has also been proposed with the CSMA to improve the CSMA.

Radha Krishna Ganti et al. focused their study on Spatial and Temporal Correlation of the Interference in ALOHA AD Hoc Networks. Here interference is an important performance metric. Correlated temporal and spatial connections existed. Interference was a drawback in terms of performance. They put forth a distributed concept for the temporal and distributed ad hoc wireless network based on Poisson concept.

Jun-Bong Eom et al. showcased the study on Accurate Tag Estimation for Dynamic Framed-Slotted ALOHA in RFID Systems. Dynamic Frame Slotted ALOHA (DFSA) is a pivotal method in resolution in tag collisions of RFID systems. So tag collision method is very important for optimal performance measure. The simulation results are indicative of efficiency in performance after implementing it. They proposed a robust tag estimation method. It serves to be an effieceint mechanism for RFID systems.

Cedomir Stefanovi´c et al. proposed their analysis and sudy on Frameless ALOHA Protocol for Wireless Networks. It was based on Slotted Aloha concept that was based on the principles of interference cancellation. The user data transmissions are kind of distributed over various slots. They proposed this method that ensures each user in an independent manner has access to the wireless network with a pre defined possibility. This is mainly done to optimize the entire slot access mechanism to reduce the lags and problems and thereby enhancing the overall system performance completely and with a greater focus on the equal access for all users. The interference is prevented and driven out as swiftly as possible which helps the system in attaining good performance and efficacy of oveall results for the proposed system.

F. V´azquez-Gallego et al. laid out a Performance Evaluation of Frame Slotted ALOHA with successive Interference Cancellation in Machine to Machine Networks. This is mainly done with focus on energy efficient methods where M2M machines are used considerably for the energy efficiency. It serves a doorway to a number of energy clad end devices and methods.

It is shown to reduce delays and energy consumption to a great level. Over all it stands as a very efficient and feasible method to ensure great performance.

Claire Gousaud et al. put forth a study on Randon Unslotted Time Frequency ALOHA. It finds its foundation and basis on the Internet of Things. It is a relatively new and fresh concept allied to networking on internet. It kind of collects data that can utilized in a broad domain of applications for various uses. The various aspects can be industrial uses and home automation etc. The ALOHA protocol is re inventing its concept with respect to Internet of Things concept. This paper lays focus on successful generalization of ALOHA based on frequency slotted systems like the UNB. Time frequency random access is applied. With the combined concept of ALOHA and IoT further the performances and benefits can be harnessed to a considerable extent.

Enrico Paolini et al. threw light on the mechanism of coded slotted Aloha. This study also introduced a random access method that was based on correcting codes and cancelling out the interferences. Iterative interference subtraction is implemented to enhance the functional metric value. This paper demonstrated the successful evaluation of the ALOHA throughput based on UNB transfer of data.

III. ALOHA TYPES

Fundamentally ALOHA protocol used for IoT applications are categorized into two categories v.i.z. pure ALOHA and slotted ALOHA.

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

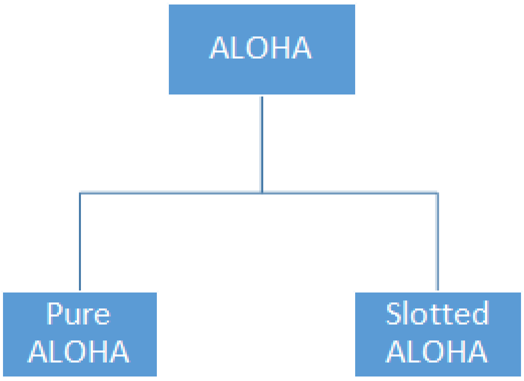

Fig.3 ALOHA Types

There are two basic types of ALOHA system:-
1. Pure ALOHA.
2. Slotted ALOHA.

In pure ALOHA a node can start transmission at any time. In slotted ALOHA, all nodes have synchronized clocks marking frame boundary times. The main advantage of pure ALOHA is the simplicity of its operation, whereas the major downside is the collision among data packets due to the absence of knowledge of channel states. This is often overcome using slotted ALOHA where time slots are fixed for users. Any user who wants to send data packets

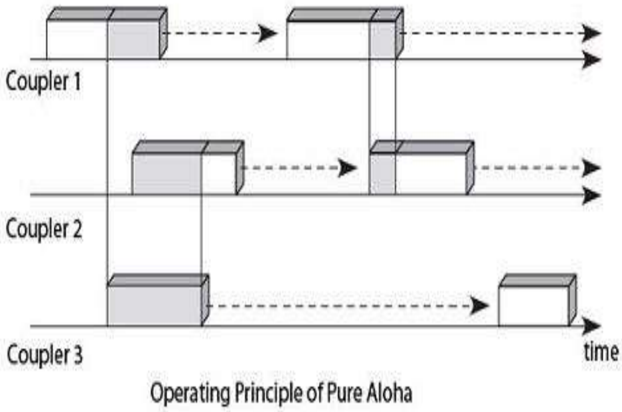

Fig.4 Pure ALOHA

The Pure ALOHA just allows every station to transmit the data whenever they have the data to be sent. When every station transmits the data without checking whether the channel is free or not; there is always the possibility of the collision of data frames.

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

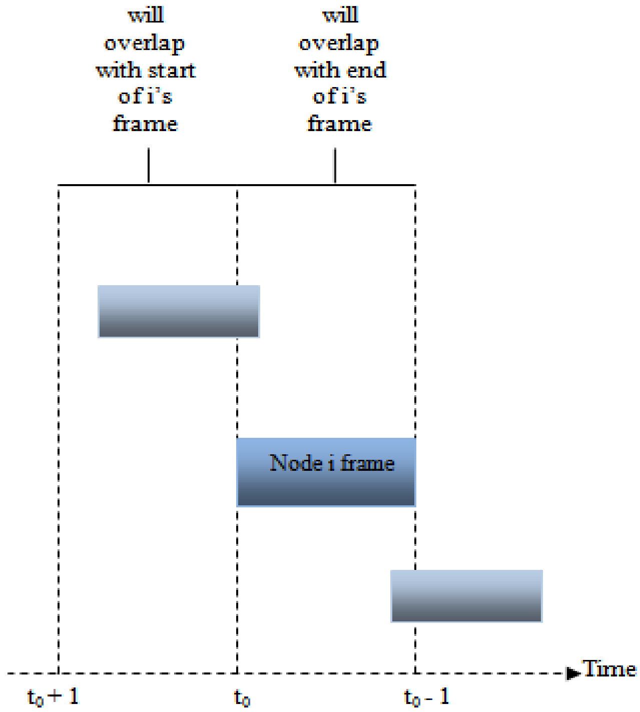

Fig.5 Interference in Pure Aloha

If the acknowledgment arrived for the received frame, then it is ok or else if the two frames collide, they are damaged. It just takes into consideration that a node wanting to send any packet of data must send it regardless of what any other node is doing. If a node sends the data packet and mean while any other node also happens to send any data, it is termed as the collision. In case of collision the data packets are required to be re sent at a later time. This Re sending later concept reduces the overall efficacy of the networking system.

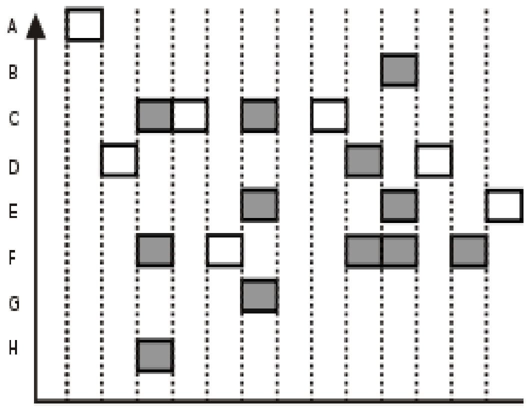

Fig.6 Slotted ALOHA

Slotted ALOHA is an improved version of the pure ALOHA. It is based on starting the transmission after waiting for some period of time and not instantly. It is divided into specific time slots that need to be taken into consideration. It consists of frames that have exactly the same number, say L number of bits.[15]

The time is divided into specific slots of size L/R seconds. The nodes need to sent only at the beginning of the timed slots. Synchronization is present in Slotted ALOHA. So that the nodes know which slots time begins when. Collision detection is very efficient in this. It kind of represented the use of discrete slots of time for transmission. This helped in increasing the throughput considerably. [15]

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

The efficiency is given by:

$$\eta = G.e^{-2G} \quad (1)$$

Here,
G is the number of stations wanting to transmit in a particular time frame T_T
The maximum efficiency can be computed by equation

$$d\eta/dG = 0 \quad (2)$$

This yields G=1/2
Substituting G=1/2 in equation (1),
We get $\eta_{Max} = 0.5e^{-1} = 0.184 = 18.4\%$.

This is rather a low value, which indicates the fact that pure ALOHA has low efficiency.

This means half station wants to transmit in one time slot or one station wants to transmit in two time slots. This greatly reduces the probability of collision among the transmitting stations. The following figure illustrates the concept.

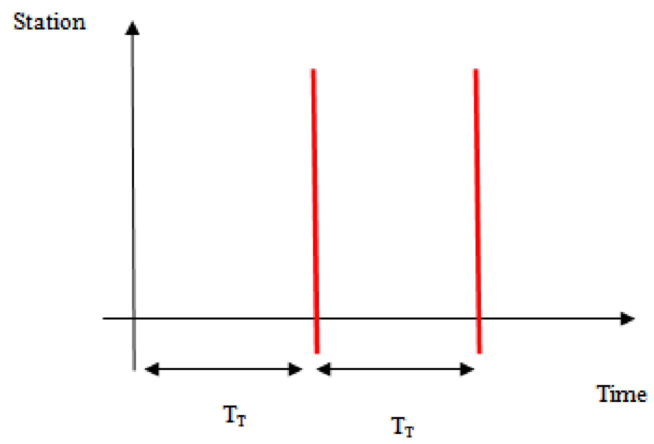

Fig.7 One station per two time slots for maximum efficiency

In case of slotted ALOHA, each station is forced to transmit only at the beginning of a time frame T_T, so the collision can happen only during one time slot. Substituting the value of G=1 in (1), we get,
$\eta_{Max} = 36.8\%$

So, he major demerit in Pure ALOHA was it was not possible to know whether the destination node received the sent data properly. This problem was overcome in the slotted ALOHA efficiently with the Acknowledgment mechanism where the sending node expects an ACK from the destination node otherwise it re transmits the data after a certain period of time. Hence Slotted ALOHA yielded more throughput and efficiency for the data transmission. It brought in more reliability.

IV. PERFORMANCE EVALUATION PARAMETERS

The performance evaluation parameters for Ultra-Narroeband (UNB) application such as that for IoT applications are:
1) Effective Bandwidth
2) Throughput
3) Bit Error Rate

Typically, UNB networks are limited in data rate due to the low available bandwidth. The effective bandwidth moreover depends on the efficiency of the random access protocol. The effective bandwidth is mathematically defined as:

$$B' = B.\eta \quad (3)$$

Here,
B' represents the effective bandwidth
B represents the available bandwidth
η represents the efficiency

The throughput is defined as:

T=D/t (4)

Here,
T represents the throughput
D represents the data size transmitted
T represents time for transmission

Bit Error Rate (BER) is represented by:

BER=number of error bits/total number of bits (5)

The throughput of the system should be as high as possible while the BER should be as low as possible.

V. CONCLUSION

So it is concluded from the aforementioned discussions that Ultra Narrowband (UNB) IoT based applications need random access protocols. ALOHA serves to be an integral part of the entire data transmission system architecture in the aspect of networks for packet data transfer and suits the IoT framework well due to low overhead and simplicity. The slotted ALOHA as observed is an improved and robust version of the Pure ALOHA mechanism. The main and chief goal for the ALOHA systems is to maximize the throughput and reduce BER to attain satisfactory system performance.

VI. REFERENCES

[1] Claire Goursaud and Yuqi Mo, "Random Unslotted Time-Frequency ALOHA: Theory and Application to IoT UNB Networks", 2016 23rd International Conference on Telecommunications (ICT).
[2] Enrico Plaini, Gianluigi Liva Marco Chiani "Slotted Aloha:A Graph Based Method for UnCoordinated Multiple Access", IEEE TRANSACTIONS ON INFORMATION THEORY, VOL. 61, NO. 12, DECEMBER 2015
[3] F. V´azquez-Gallego et al., "Performance Evaluation of Frame Slotted-ALOHA with Successive Interfrence Cancellation in Machine-to-Machine Networks", European Wireless 2014.
[4] Cˇ edomir Stefanovic´, Peter Popovski, "A Random Access that Opertates as a Rateless Code IEEE TRANSACTIONS ON COMMUNICATIONS, VOL. 61, NO. 11, NOVEMBER 2013.
[5] Cedomir Stefanovi´c, et al., Frameless ALOHA Protocol for Wireless Networks", IEEE COMMUNICATIONS LETTERS, VOL. 16, NO. 12, DECEMBER 2012.
[6] Gianluigi Liva, "Graph Based Analysis and Optimization of Contention Resolution Diversity Slotted ALOHA", IEEE TRANSACTIONS ON COMMUNICATIONS, VOL. 59, NO. 2, FEBRUARY 2011.
[7] Jun-Bong Eom et al., "Accurate Tag Estimation for Dynamic Framed-Slotted ALOHA in RFID Systems, IEEE COMMUNICATIONS LETTERS, VOL. 14, NO. 1, JANUARY 2010.
[8] Radha Krishna Ganti et al., "Spatial and Temporal Correlation of the Interference in ALOHA Ad Hoc Networks", IEEE COMMUNICATIONS LETTERS, VOL. 13, NO. 9, SEPTEMBER 2009.
[9] M. Sarper Gokturk, Ozgur Ercetin, Ozgur Gurbuz, "Throughput Analysis of ALOHA with Cooperative Diversity", IEEE COMMUNICATIONS LETTERS, VOL. 12, NO. 6, JUNE 2008.
[10] Mariam Kaynia and Nihar Jindal, "Performance of ALOHA and CSMA in Spatially Distributed Wireless Networks", in: IEEE 2008.
[11] N. Abramson "The Throughput of Packet Broadcasting Channels", IEEE Transactions on Communications, Vol 25 No 1, pp117–128, January 1977.
[12] R. Binder, ALOHAnet Protocols, ALOHA System Technical Report, College of Engineering, The University of Hawaii, September, 1974.
[13] R. Binder, W.S. Lai and M. Wilson, The ALOHAnet Menehune – Version II, ALOHA System Technical Report, College of Engineering, The University of Hawaii, September, 1974.

[14] R. Metcalfe, Xerox PARC memo, from Bob Metcalfe to Alto Aloha Distribution on Ether Acquisition, May 22, 1973.

[15] Data Communication and Networking by Forouzan, 4th edition, Mc Graw Hill

CITE AN ARTICLE

Badgotya, S., & Rai, D., Prof. (2018). A SURVEY ON ALOHA PROTOCOL FOR IOT BASED APPLICATIONS. *INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY*, *7*(5), 289-297.